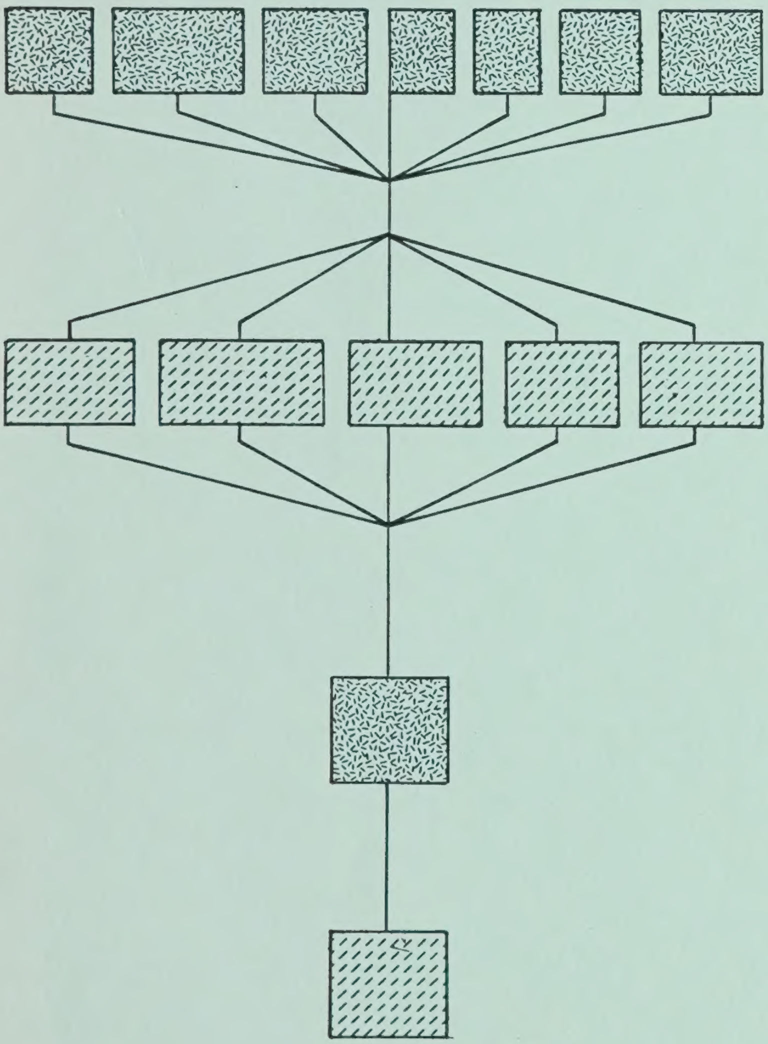
City of Merced

ENVIRONMENTAL RESOURCES MANAGEMENT PLAN



noise

86 01810

Prepared by
Merced City Planning Department
Merced, California

January, 1976

C I T Y O F M E R C E D

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CITY OF MERCED
Planning Commission

RESOLUTION #1135

WHEREAS, the Merced City Planning Commission at its regular meeting of August 6, 1975, considered an expanded version of the Noise Element of the City of Merced General Plan; and,

WHEREAS, an environmental assessment was made and a Negative Declaration was issued upon determination by the Responsible Official (Planning Director) that no significant negative environment impact would accrue from the goals and policies contained within this element; and,

WHEREAS, upon due public notice a public hearing was conducted on August 6, 1975; and,

WHEREAS, no one spoke at the public hearing and one letter was received and a number of verbal comments and suggestions were received by the Planning Staff prior to the above meeting; and,

WHEREAS, the Merced City Planning Commission made the following findings:

1. The Environmental Resources Management Plan (ERMP) portion of the Merced City General Plan contains a preliminary Noise Element, approved by the Merced City Planning Commission at its meeting of March 25, 1974, and subsequently adopted by the Merced City Council at its May 6, 1974, meeting.

2. The State of California had mandated that such an element be prepared by September 20, 1974, by cities and counties within the State, but the City of Merced had requested and had received an official extension to September 20, 1975, to update this element consistent with current requirements.

3. The Noise Element has been developed following present State guidelines.

4. This proposed final Noise Element, along with the proposed final Seismic Safety/ Safety Element, and the completed Conservation, Open Space, and Scenic Highways Elements, comprise the Environmental Resources Management Plan (ERMP) portion of the Merced City General Plan.

5. The Noise Exposure Forecast (NEF) Map issued in September, 1974, concerning Castle AFB related noise, and the U.S. Department of Housing and Urban Development (HUD) Environmental Impact Statement (EIS) currently being prepared dealing with the map's potential effects on this community, may cause the need for expansion and further updating of this element as additional information becomes available and related decisions are possibly made.

NOW, THEREFORE, BE IT RESOLVED that the Merced City Planning Commission does approve the Noise Element as modified by the Commission at this meeting, and does recommend that the Merced City Council adopt this element, as modified.

AYES: Commissioners Irwin, Hart, Weber, Green, Chairman Fisher

NOES: None

ABSENT: Commissioners Passovoy, Riggs

Adopted this 6th day of August, 1975.

Chairman, Planning Commission of the
City of Merced, California

ATTEST:

Secretary

RESOLUTION NO. 75-96

GENERAL PLAN - ADOPTING NOISE ELEMENT

BE IT RESOLVED by the City Council of the City of Merced as follows:

1. The Noise Element of the General Plan of the City of Merced, heretofore approved by the Planning Commission of the City of Merced, is hereby approved and made part of the General Plan of the City of Merced, in accordance with the provisons of Government Code §65357.

2. The City Clerk shall endorse upon the General Plan of the City of Merced the fact of adoption of the above named element by this resolution and the date of such adoption.

Duly and regularly adopted by the City Council at its regular meeting held September 2, 1975.

APPROVED:

William P. Quigley

WILLIAM P. QUIGLEY, MAYOR

ATTEST:

ALLAN R. SCHELL, CITY CLERK
By: William H. Cunningham
WILLIAM H. CUNNINGHAM
DEPUTY CITY CLERK

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TABLE OF CONTENTS (CONTINUED)

*The NOISE ELEMENT is one of five elements

I. Conservation Element
II. Scenic Highways Element
III. Seismic Safety/Safety Element
IV. Noise Element
V. Open Space Element

that together form the City of Merced's Environmental Resources Management Plan (ERMP), Volume 1 of the City's General Plan.

Pages herein are identified by a combination of Roman numerals (indicating the number of this particular element) and Arabic numerals (indicating the actual page number).

LIST OF FIGURES/MAPS

NOISE ELEMENT

NOISE ELEMENT

Noise pollution is the quiet, sleeper issue of the environment crisis and when our people are fully aware of the damage done, peace and quite surely will rank along with clean skies and pure waters as top priorities for our generation.

- Governor Nelson Rockefeller -

INTRODUCTION

Government Code Section 65302(g) requires all cities and counties to include in their general plans a noise element that analyzes all noise associated with different forms of transportation.[1] The main purpose of the element is to become more aware of the existing and projected noise levels, and to determine whether people are or will be subjected to inordinately high noise levels that may adversely affect their physical, mental, social or economic well-being.

The State Code has listed several items that are to be included in the noise element:

1. Noise contours of present and projected noise levels of highways, railroads, and airports licensed by the state.
2. These contours are to be shown in increments of five decibels (A scale), down to 65 dB(A). (Definitions are on pp. IV-3 to IV-7.) For regions involving hospitals, rest homes, long-term medical or mental care, or outdoor recreational areas, the contours are to be continued down to 45 dB(A).

SCOPE OF THE NOISE ELEMENT

This element fulfills the state requirements and includes comments on other types of noise environments. Over the years, man has been subjected to ever increasing noise levels, both in and outside the home. Because both the cumulative and omnipresent aspects of noise have an impact on man, noise levels for both indoor and outdoor environments have been studied and included.

Figure IV-1

Growth in Noise Sources

(M = Million, TH = Thousand)

Year:	1950	1960	1970
Population (M):	151	181	204
Transportation Vehicles			
Cars, Buses, Trucks (M)	49.2	73.9	106.3
Motorcycles (M)	0.45	0.51	3.0
Powered Boats (M)	2.6	4.7	5.8
Snowmobiles (TH)	0	2	1600
Commercial Aircraft (Turbofan) (sic)	0	202	1989
Private Aircraft (TH)	45	76.2	136
Outdoor Appliances (Approximate)			
Lawn Mowers (M)		10	17
Chain Saws (M)		.5	1.2
Home Appliances	1950	1960	1970
Dishwashers (M)	1.3	3.2	14.9
Clothes Washers (M)	32.2	42.0	57.6
Clothes Dryers (M)	1.5	9.0	25.3
Air Conditioners (M)	0.6	6.5	23.0
Food Mixers (M)	12.6	27.0	51.2
Food Waste Disposers (M)	1.4	4.8	14.4

Based on EPA reports by Wyle Laboratories and Bolt, Beranek and Newman.
(Source: Environmental Protection Agency, Social Impact of Noise, p. 5)

Methodology

The element is divided into several sections. This section is an introduction to the characteristics of noise and includes definitions of terms that will be used throughout the study. The second section, describing the psychological and physiological effects of noise, gives reasons for being concerned with the rising noise levels. The third and fourth sections include the social and economic impacts of noise on man. In the fifth section, the sources of noise in the City and Planning Area of Merced are described, including the noise generated by Castle Air Force Base traffic (see p. IV-19). The existing federal, state and city regulations on noise have been outlined in the sixth section, giving an indication of what has been done to alleviate the noise

problem to date. The seventh section is an outline of the goals and policies that have been considered appropriate for the City of Merced to follow. A final section of text includes selected design techniques to illustrate current methods being used to reduce noise levels in the home, along the highways, and in general, throughout the city.

Basic Characteristics of Noise

Only those terms that are basic to all types of noise will be considered in this section. Terms that are directly connected to the different impacts of noise -- physical, mental, social, or economic -- will be discussed in the pertinent sections.

Noise

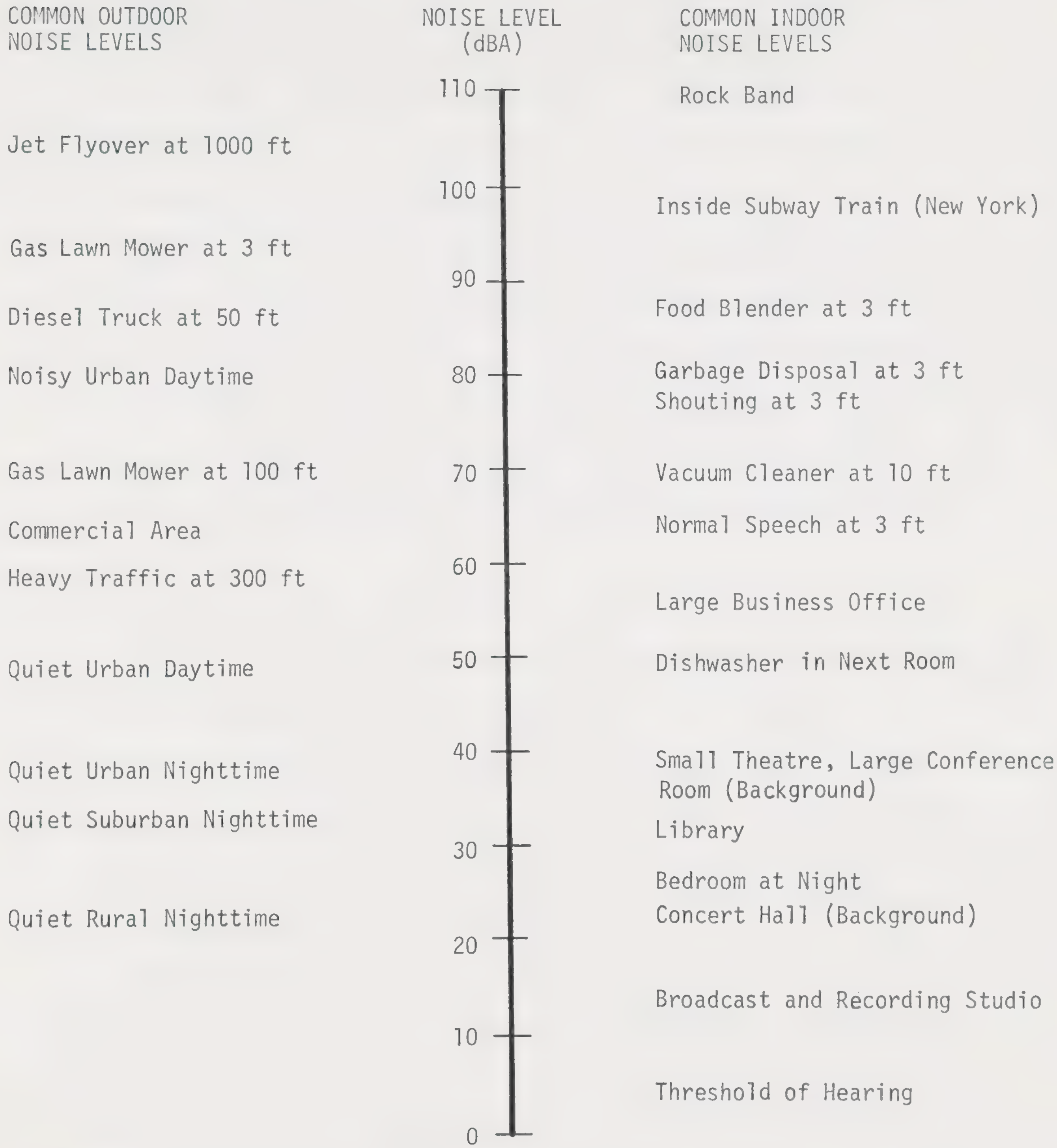
Noise is sound that the individual considers unwanted, uncomfortable or aesthetically displeasing. Because noise is a subjective determination, it is possible for one person to consider a sound to be noise and another person to consider the same sound pleasing.

The degree of disturbance from noise depends upon three factors: (1) the amount (amplitude) and nature (frequency) of the intruding noise, (2) the amount of background noise present before the intruding noise, and (3) the nature of the working or living activity of the people occupying the area where the noise is heard.[2] A smooth, continuous flow of noise is more comfortable or acceptable than impulsive or intermittent noise, even though all of these noises might be judged as unwanted. Noises that are more identifiable tend to be more annoying. Other terms defined below are additional characteristics of sound that help determine whether the sound will be considered pleasing or displeasing.

Figure IV-2 illustrates the noise levels of various noise sources.

Figure IV-2

COMMON INDOOR AND OUTDOOR NOISE LEVELS



(Source: U.S. Department of Transportation, Fundamentals and Abatement of Highway Traffic Noise, p. 4, Appendix)

Sound

Sound is a mechanical form of radiant energy which is transmitted in waves through the air (or other medium) and received as vibrations on the ear drum. Sound waves are measured in terms of frequency or number of cycles per second and in terms of amplitude or decibels.[3]

Frequency (cycles per second)

Frequency or pitch is influential in determining the pleasantness of a sound. The human ear can perceive frequencies as low as 15 cycles per second (or Hertz, abr.: Hz) which would be a very low rumble, and as high as 20,000 cycles per second, a very high screech. The piano ranges from a low of 28 Hz to a high of 4186 Hz.[4] High frequencies are more irritating to the human ear and can make a low volume noise seem noisier.[5]

Amplitude

Decibels, the unit of measurement for amplitude, make up a logarithmic scale.[6] Instead of increasing arithmetically as in cycles per second decibels increase exponentially as is characteristic with the Richter scale used in measuring the force of an earthquake. There are several adaptations of the decibel unit of measurement that take into account the way humans react to sound. These adaptations are listed below.

Decibel (A Scale) - dB(A)

The decibel scale is relative to the human ear, with 0 decibels being the threshold of hearing. Because the human ear's perception of sound varies with the frequency, a modified decibel scale has been developed which incorporates the human's greater sensitivity to high frequency sound and lower sensitivity to low frequency sound.[7]

L_{10}

In measuring a sound that is recurring but not maintaining a constant level, it is necessary to get a sound reading that takes into account

the inconstancy of the sound. L_{10} measurements indicate a sound level that is being exceeded 10 percent of the total time.[8]

Day-Night Average Sound Levels (L_{dn})

This method of measuring sound levels incorporates the noise from the individual events and weights them according to time of day of the event. The 24-hour day is divided into two time periods: day, 7 a.m. to 10 p.m., and night, 10 p.m. to 7 a.m. In order to more accurately reflect the annoyance level of the day- and night-time events, they are weighted by a multiplier of 1 for day and 10 for night.[9] Unlike the L_{10} method, L_{dn} does not measure the actual noise of, for example, passing trains, but rather the average noise over a period of 24 hours.

Noise Exposure Forecast (NEF)

The NEF scale utilizes a decibel scale similar to the dB(A) scale in that it reflects the same sensitivities of the human ear. However, the base scale used in computing NEF is more sensitive to noisiness while the dB(A) scale is more sensitive to loudness. This base scale is used in drawing "Effective Perceived Noise Level" contours that characterize the noise, generated by each type of aircraft. NEF also accounts for the number of events daily and the time of day of each event, giving night events more weight.[10]

Decibel Addition

Decibels progress at a logarithmic rate. As a result, when two sounds of 90 dB(A) are produced together, the combined dB(A) reading will be 93 dB(A) and not 180 dB(A).[11] The following chart can be used to determine the sound level of the combined sounds:[12]

When two decibel values differ by:	Add the following amount to the higher figure:
0 - 1 dB	3 dB
2 - 3 dB	2 dB
4 - 9 dB	1 dB
10 or more dB	0 dB

The human ear, however, perceives a doubling (or halving) of loudness for every change of 10 dB(A).[13]

Attenuation

Sound from a localized source spreads out uniformly and the rate of attenuation (sound reduction) is about 6 dB for every doubling of distance, varying somewhat according to humidity, temperature, and other climatic conditions.[14] Therefore, if a sound is 60 dB at 50 feet, it will read 54 dB at 100 feet. At very long distances (greater than a few hundred feet), and especially in a hot, dry climate, the air absorbs a certain amount of high frequency energy and the sound level drops off at a slightly higher rate.[15] For a line source like non-stop automobile traffic, the rate of sound attenuation is 3 dB for each doubling of distance.[16] Because traffic is seldom sufficiently constant to use the line source rate of attenuation, the National Cooperative Highway Research Program has adopted a 4.5 dropoff rate for highway traffic.[17]

PSYCHOLOGICAL AND PHYSIOLOGICAL EFFECTS OF NOISE

The psychological and physiological effects of noise have been studied, but not to such an extent that conclusions can be drawn with any degree of finality.[18] Further research may determine that existing noise levels are and have been having a severe impact on health, or it may find that human beings can tolerate much higher everyday noise levels without ill effects. The following discussion describes three areas where concern has encouraged research. While the results of

this research are not conclusive, the potential damage should be sufficient to warrant concern. "There is no definitive evidence that noise can induce either neurotic or psychotic illness. There is evidence that the rate of admissions to mental hospitals is higher from areas experiencing high levels of noise from aircraft operations than in similar areas with lower levels of noise."[19]

Hearing Ability

"Clear evidence is available that noise with A-weighted sound levels above 80 decibels can contribute to inner ear damage and eventual hearing handicap if such noises are frequently and regularly encountered."[20] A slight hearing loss at an early age may be considered insignificant. However, when combined with the natural decrease in hearing ability due to old age, the total hearing loss may become significant.[21] The exposure to a combination of noise sources may be damaging even though exposure to the same sources individually is not.[22] For this reason, any significant noise sources should be included in the study of the overall community noise exposure level.

Sleep

Sleep is characterized by deep and light stages. Evidence of sleep disturbance includes the act of awakening and also movement from a deep to a light stage of sleep. Motivation (will to awake) affects the probability of awakening to noise. Men and women vary in sensitivity to noise during sleep. Research points out that "sleep disturbance from subsonic-aircraft noise or sonic booms is greater for middle-aged women than for middle-aged men. Thus, it appears that women's sleep is more easily disturbed by noise than is men's, even when other variables such as motivation and stage of sleep are equated."[23] In other research, it was found that people over 60 years of age are more sensitive to

noise while sleeping and, if awakened, find it more difficult to fall back to sleep compared to people in other age groups.[24]

Evidence suggests that it is unlikely that the individual can adapt to a strong stimulus. The highest degree of adaptation to noise will probably be apparent in not awakening or awakening for shorter periods. It will be less likely that the individual will adapt to an extent that upward shifts from deep to light sleep are experienced and it is improbable that there will be complete adaptation as shown in responses to the electroencephalogram (EKG-method of measuring heart rhythms) and in changes in heart rate and blood flow.[25] In other words, while the individual may think he is completely adapting to the high noise level, he is probably only adapting partially: instead of awakening, he is moving into a lighter stage of sleep or instead of moving into a lighter stage of sleep, he is registering changes in blood flow and heart rate and rhythm.

Miss Alice Suter of the National Association of Hearing and Speech Agencies noted in EPA testimony:[26]

> *The idea that people become adapted to noise is really a myth. As I mentioned previously, the circulatory system does not adapt. Also, studies have shown that people who work in high noise levels during the day are more rather than less susceptible to aggravation from noise after work. The factory worker is more apt to explode at his noisy children than the man who works in a quiet office.*

Although it may appear that adaptation is taking place, it may also be that one of the following is occurring: (1) change in the motivation to awake; or (2) amnesia for awakening, that is, the individual underestimates the number of incidences of awakening.[27] "Whether such sleep disturbance constitutes a health hazard is debatable. . . . All factors considered, one must tentatively assume that sleep disturbance by excessive noise will reduce one's feelings of well-being. Furthermore, when noise conditions are so severe as

to disturb sleep on a regular, unrelenting basis, then such sleep disturbance may constitute a hazard to one's physical and mental health."[28]

Body Stress

As found in adaptation to noise during sleep, adaptation to noise while awake is likely to be only surface adaptation. For example, for a brief sound over 70 dB(A), the body responses are still readable and can include the following: reduction in the peripheral blood flow caused by constriction; change in the heart rate; activation of the peripheral visceral nervous system; changes in breathing pattern, in the size of the pupils of the eyes, in the secretion of saliva and gastric secretions.[29] Evidence indicates that workers exposed to high noise levels have a higher incidence of cardiovascular disorders; ear, nose, and throat problems; and equilibrium disorders than do workers exposed to lower levels of noise.[30] Evidence from studies made with animals using very high noise levels suggests that exposure to these noises can interfere with sexual-reproductive functions and interfere with resistance to viral diseases.[31] In general, while the results are not conclusive, they do tend to indicate that high noises are harmful and that most efforts should be taken to decrease the level of noise in both the indoor and outdoor environments.

SOCIAL EFFECTS OF NOISE

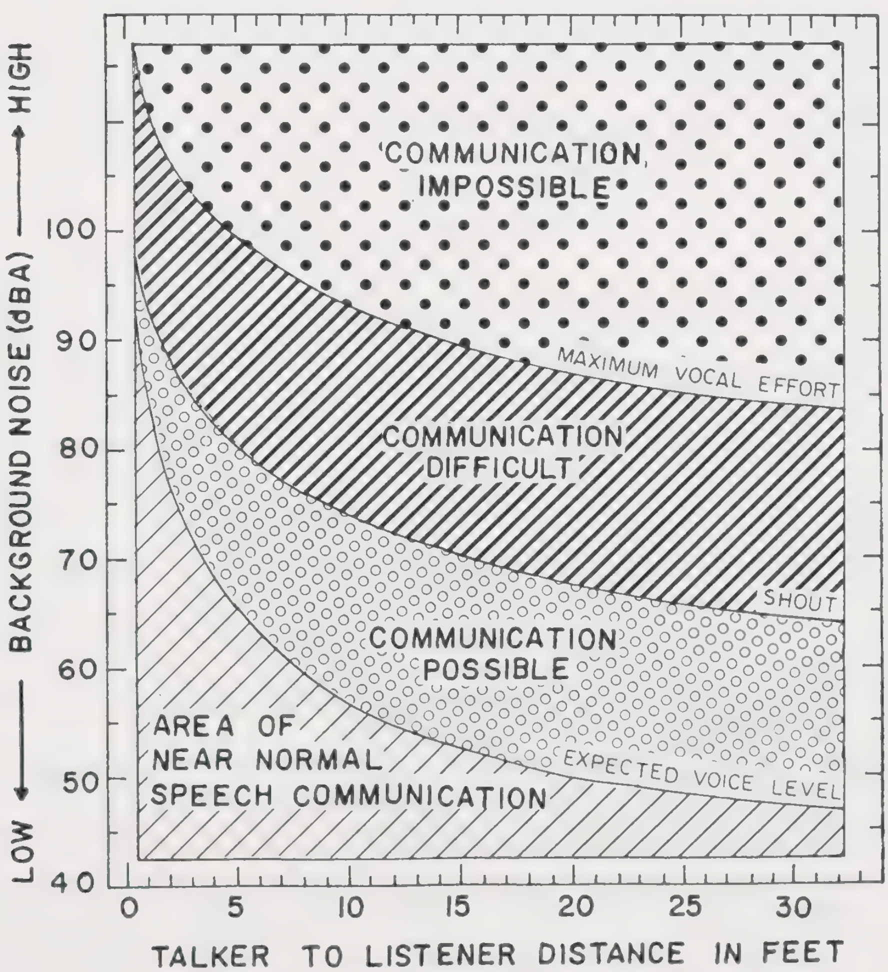
High noise levels can disrupt normal communications and cause people to change their behavior so that the noise is lessened or avoided. To some people these changes merely indicate an adaptation to the stimulus and are unlikely to do any great harm; others find the disruption and adaptative behavior to be equally damaging in

that they both discourage spontaneity. The following comments review the types of effects noise can have on communication and behavior patterns of people.

Communication

Distances between people while talking varies with the situation. In one-to-one personal conversations, this distance is usually around five feet in noise levels as high as 66 dB(A). In group situations, the distance maintained is somewhere between five and twelve feet with background noise level of no more than 50 to 60 dB(A). For outdoor gatherings where distances range from 12 to 30 feet, any noise level higher than 45 to 55 dB(A) will hinder communications.[32]

Figure IV-3



(Source: Environmental Protection Agency, Effects of Noise on People, p.50)

"Because noise can reduce the amount of speech used at home, in the yard, or on the playground and because noise can make speech difficult to understand, it is possible, though unproven, that language development of early childhood might be adversely affected. From this, difficulty in learning language and learning to read may ensue."[33]

Behavior Patterns

Not being able to communicate spontaneously or without difficulty will affect the behavior patterns of people. In one area that was subjected to high noise levels from aircraft, the impact on the community was evident in the schools. The NEF 30 or greater noise level meant that the teaching was interrupted for a total of an hour each day and a "jet pause" teaching style had to be adopted to accommodate the noise. "The noise interference goes beyond the periods of enforced non-communication, for it destroys the spontaneity of the educational process and subjects it to the rhythm of the aeronautical control system."[34]

Even when people claim they are "used to" the high noise levels, there is evidence that they have changed their behavior to suit the interference; that is, they adopt a "non-communicating life style," using less verbal communication and more non-verbal techniques: gestures, posture, and facial expressions.[35] "Even though non-verbal communication is important, it is unlikely that it is nearly as important as verbal communication. Many subtleties of life are lost when verbal communication is restricted. Among adults, free and easy speech communication is probably essential for full development of social relations and self."[36]

ECONOMIC EFFECTS OF NOISE

The economic effects of noise range from the involuntary costs

associated with lowered property values and decreased worker output to the voluntary costs of mitigating the noise problem. In many cases, the economic benefits of a project are used as the sole determinants and little attention is given to the effects on the individual's psychological, physiological, social, and economic well-being.

Property Values

Property values can be negatively affected by noise. In San Francisco, it was found the noise variable was a statistically significant determinant of property values in a majority of the cases cited.[37] In other studies, the relationship between noise and property values was confused by the rapid turnover (and, therefore, more frequent tax assessments) of housing in high noise areas. The property values in high noise areas appeared not to have been affected by the noise since the higher number of reassessments had brought the value of the house up at a more rapid rate.[38]

Job Production

High noise levels may affect worker output and worker safety. "A tired and nervous person is obviously not as attentive or able to concentrate on the tasks that he is performing as a rested and relaxed person, i.e., noise can contribute to making a person more prone to accidents in both the home and work environment."[39]

Mitigation Costs

Mitigating measures can be implemented at the noise source or at the point of reception. The amount of exposure to noise is most efficiently regulated at the source since the individual is free to participate in activities at innumberable locations that can expose

him to high noise levels. However, costs of insulating houses, constructing barriers, and obtaining easements should also be considered as long as the City does not have jurisdiction over most of the sources of noise. Examples of costs are included in the section on selected design techniques.

Products have been developed that reduce the noise generated by such things as garbage trucks, waste disposal units, truck exhaust, and garbage cans. The adoption of these products will probably take legislation since invariably the newer, more silent product is also more costly to produce.[40] "With the rapid growth in noise sources within the home, . . . and with the growth in noise-density, due to increased population concentration, these annoyance effects and the associated economic costs are likely to increase dramatically in the near future."[41]

SOURCES OF NOISE IN THE CITY OF MERCED

Major noise sources include home appliances, tools, construction equipment, and the various types of transport: vehicular, rail, and aircraft. The discussion on home appliances is limited since the City is not able to control noise output in the home. They are mentioned so that the individual has a better understanding of the omnipresent nature of noise. Construction equipment is discussed since it can be controlled, although its transient nature makes it appear to be less severe an intrusion. The more in depth analysis of transportation-related noises reflects the fact that these noises tend to dominate everyday living and, therefore, have a greater potential to harm the individual. Also, in most cases, there are mitigating measures that can be used.

Household Noise

The growth in population and rise in standards of living have resulted in more families having more appliances. The following chart illustrates the noise level and weekly operating time of several appliances and tools used about the home.

Figure IV-4

Use of Noncontrollable Noise-Producing
Appliances and Tools in Typical Households

		Household No. 1*	Household No. 2**
	Average dB(A)***	Total minutes per week	Total minutes per week
Major Appliances			
Clothes Washer	64	315	210
Vacuum Cleaner	70	90	50
Clothes Dryer	57	210	-
Room Air Conditioner	58	(full-time, seasonal)	-
Dishwasher	65	472	-
Food Disposal	70	1	-
Household Appliances			
Food Mixer	69	10	15
Can Opener	69	2	-
Sewing Machine	72	15	15
Food Blender	76	3	-
Electric Shaver	64	14	-
Power Tools			
Saw, Drill, etc.	83	10	-
Mower	(Varies)	30	-
Edger	81	30	-
Trimmer	81	4	-

*Two adults, 3 children (1 pre-school age), family income $16,000.
**Two adults, family income $8,000.
***Measurements taken three feet from source during household survey.

(Source: Environmental Protection Agency, Bolt, Beranek and Newman, Inc., Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances; 12-31-71, p. 104)

On the average, the middle-income person who spends most of the working day at home could be subjected to the above noise as much as 20 hours a week and the lower-income person could be exposed to as much as 4.8 hours of noise from appliances.

Construction Noise

Because construction noises are transient, there has not been a concerted effort to reduce the noise levels of the equipment involved. As the City expands and as the older areas are renewed and rehabilitated, the noise from construction will be more noticeable. The following chart lists the types and noise levels of equipment used during the different phases of construction.

Figure IV-5

Noisiest Equipment Types Operating at Construction Sites*

Construction Type

	Domestic Housing	Office Buildings	Public Works
Ground clearing	Truck (91)	Truck (91)	Truck (91)
	Scraper (88)	Scraper (88)	Scraper (88)
Excavation	Rock Drill (98)	Rock Drill (88)	Rock Drill (98)
	Truck (91)	Truck (91)	Truck (91)
Foundations	Concrete Mixer (85)	Concrete Mixer (85)	Truck (91)
	Pneumatic Tools (85)	Jack Hammer (88)	Scraper (88)
Erection	Concrete Mixer (85)	Derrick Crane (88)	Paver (89)
	Pneumatic Tools (85)	Jack Hammer (88)	Scraper (88)
Finishing	Rock Drill (98)	Rock Drill (98)	Truck (91)
	Truck (91)	Truck (91)	Paver (89)

*Numbers in parentheses represent typical dB(A) levels at 50 feet. (Source: Environmental Protection Agency, Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances, Bolt, Beranek and Newman, Inc., December 31, 1971, p. 27)

Vehicular Noise

Method of Measurement

The varying constancy of vehicular traffic necessitates a system of measurement that is sensitive to changes in flow. The percentages involved in using the L_{10} method make it most suitable for indicating noise levels of traffic. As described in the second section, the L_{10} equals the noise level in dB(A) that has been exceeded at least ten percent of the time.

Noise Contours

The State Department of Transportation has developed noise contours showing existing and projected noise levels along state highways and freeways. The existing measurements were derived using a traffic noise model (National Cooperative Highway Research Program #117) and no onsite measurements of noise were taken. In accordance with the state guidelines, the noise contour values have been extrapolated down to 45 dB(A) noise level for highways adjacent to Merced General Hospital and McNamara and East Merced Parks. (See Appendix IV-A, p. IV-A-2 for figures and p.IV-27 for contours.)

The noise levels projected for 1995 are probably overestimated as a result of two factors: (1) it was assumed that trucks, normally the controlling traffic noise, would not be subject to noise abatement, and (2) traffic demand forecasts rather than projected traffic were used. This second factor ignores the possibility of traffic demand exceeding the capacity of the highways.[43] Using the same traffic noise model, L_{10} noise contours have been computed for Olive Avenue and "G" Street. (See Appendix IV-A, p. IV-A-3.)

Noise Abatement Techniques

Several approaches can be taken to lower the existing noise levels. Vehicular noise could be lowered through enforcement of existing noise levels and, if federal or state legislation provided the proper incentive, quieter vehicles could be produced. Reducing the traffic speed can reduce noise output as illustrated below:[44]

at 70 mph	71 dB(A)
60 mph	69 dB(A)
50 mph	67 dB(A)
40 mph	64 dB(A)
30 mph	60 dB(A)

Barriers could be used to provide some noise attenuation. As explained on Page IV-32, the amount of noise attenuation depends upon

the material and design of the barrier. Solid structures provide the most attenuation; vegetation in quantity also abates noise. An intervening row of buildings will decrease the amount of noise reaching more distant property.

Road Design Changes

Measures that eliminate stop-and-go traffic help to reduce noise levels. To a certain extent, grade separations will do this, although increased acceleration of trucks will minimize the benefits. Wider rights-of-way could reduce the possible impact on adjacent land uses in that buildings would be farther removed from highways. Recessing the roadway would also reduce noise levels on adjacent property; elevating the roadway would reduce noise levels on adjacent property, but would not lower noise levels for upper stories or buildings farther from the roadway.

Rail Traffic Noise

Method of Measurement

In measuring the noise levels of rail traffic there must be some indication of train frequency and time of passage. The Day-Night Average Sound level method does this by incorporating the noise from the individual events and weighting them according to time of day of the event. A train passing between the hours of 7 a.m. and 10 p.m. is multiplied by a factor of 1, while a train passing between the hours of 10 p.m. and 7 a.m. is multiplied by a factor of 10. This widely used method more accurately reflects the annoyance level of the rail traffic.

Noise Contours

Using a tested model, noise contours have been developed for both the Southern Pacific and Atchison, Topeka and Santa Fe

traffic (See p. IV-27).[46, 47, 48] The contours reflect the peak season traffic from mid-July to mid-September (The computations have been included in Appendix IV-A, p. IV-A-5).

Noise Abatement Techniques

Like vehicular traffic, trains result in a linear noise pattern. Noise attenuation measures used to abate noise along highways can be used along railways. Other methods are possible, including reducing the speed of the train, improving the rail connections, and limiting night-time traffic. Rerouting of rail traffic onto one railway would eliminate the noise problem in one area, but increase it in the other. Where there is a difference in sensitivity to noise between two areas, rerouting could be a suitable mitigation measure, although modification costs and local conditions could make it impractical.

Aircraft Noise

Method of Measurement

The City of Merced is impacted by the noise from two airports: Merced Municipal Airport and Castle Air Force Base. Noise Exposure Forecast (NEF) contours, drawn to reflect the noise generated by both facilities, are derived from the average daily number of flights and time of flight for each type of aircraft, and the Effective Perceived Noise Level contours characteristic of each type of aircraft (see Appendix IV-A, p. IV-A-6 for formula used).

Noise Contours

The noise contours developed for Castle Air Force Base by the U.S. Department of the Air Force, appearing on undated maps within a report entitled Air Installation Compatible Use Zone (AICUZ) (September, 1974) combined with the contours for the Merced Municipal

Airport,[49] are illustrated on Page IV-27. The noise generated by the Merced Municipal Airport appears to only slightly affect the current noise contours for Castle Air Force Base traffic.

The U.S. Department of Housing and Urban Development (HUD) has developed land use policies for application in noise impacted areas. With these, HUD hopes "to encourage land utilization patterns for housing and other municipal needs that will separate uncontrollable noise sources from residential and other noise-sensitive areas, and to prohibit HUD support to new construction on sites having unacceptable noise exposures." (HUD Circular 1390.2, "Noise Abatement and Control: Departmental Policy, Implementation Responsibilities, and Standards.")

The NEF contours utilized by the U.S. Air Force to describe noise impact from Castle AFB are characterized by HUD as follows:

NEF contour level	HUD policy
Under 30 NEF	Acceptable external noise exposure conditions for new residential construction sites
30-40 NEF	Discretionary external noise exposure conditions for new residential construction sites (approval of such a site would depend upon proposed noise attenuation methods, the HUD Regional Administrator's concurrence, and environmental evaluation)
40 or greater NEF	Unacceptable external noise exposure conditions for new residential construction sites

These HUD policies, presently in effect in the Merced area, are being implemented through denial of federal loan programs (e.g., FHA and VA) in noise impacted areas.

One can perceive the potential impact of such policies on Merced through the following figure which illustrates the estimated portions of the City falling within the above NEF contour groupings as of April, 1975:

special problem in that it is difficult (or dangerous) to modify flight patterns or landing and take-off procedures. A heavy turnover of trainees may mean a tight schedule has to be followed, thus limiting flexibility in another way.

The most effective means for reducing the impact of aircraft noise is to prohibit noise sensitive uses in high noise areas through land use planning and zoning. In some areas, including Los Angeles, restrictive zoning around airports was found to be a "taking" of land (that is, taking without just compensation) resulting in law suits and eventual purchase of the impacted land.[51] Planning should be initiated early to reduce the possibility of development occurring in areas impacted by aircraft noise.

In the Merced situation, however, the problem appears to have developed not so much from incremental land use decisions as from the initial relationship of an airport facility to an existing community. Expansion of the air base during wartime conditions, along with the continual changes in air base mission and advancements in aircraft technology have led to higher noise impact levels.

Under such circumstances, it would not be surprising if most area residents respond to recent focus on the area's noise problem by pointing out how the community has lived and grown with aircraft noise for many years, developing into a stable, quality community.

NOISE POLLUTION STANDARDS

As noise levels have risen, federal, state, and local governments have become more concerned and more willing to consider methods for reducing exposure to noise. These methods include setting limits on the noise levels that can be produced by a piece of equipment and limiting the noise that can be experienced by a particular land use. Discussion of the existing standards and regulations enacted to reduce noise levels has been included here for review.

Federal Noise Standards

At the federal level, standards are currently being developed that would limit the noise levels of individual appliances and tools used in construction, industry, and about the home. For the products now identified (Federal Register, Vol. 40, No. 103; May 28, 1975), additional information will be provided on techniques for control of noise, costs, and alternative methods of control.

As shown on the following chart, standards have been adopted with regard to aircraft and highway traffic.

Figure IV-7

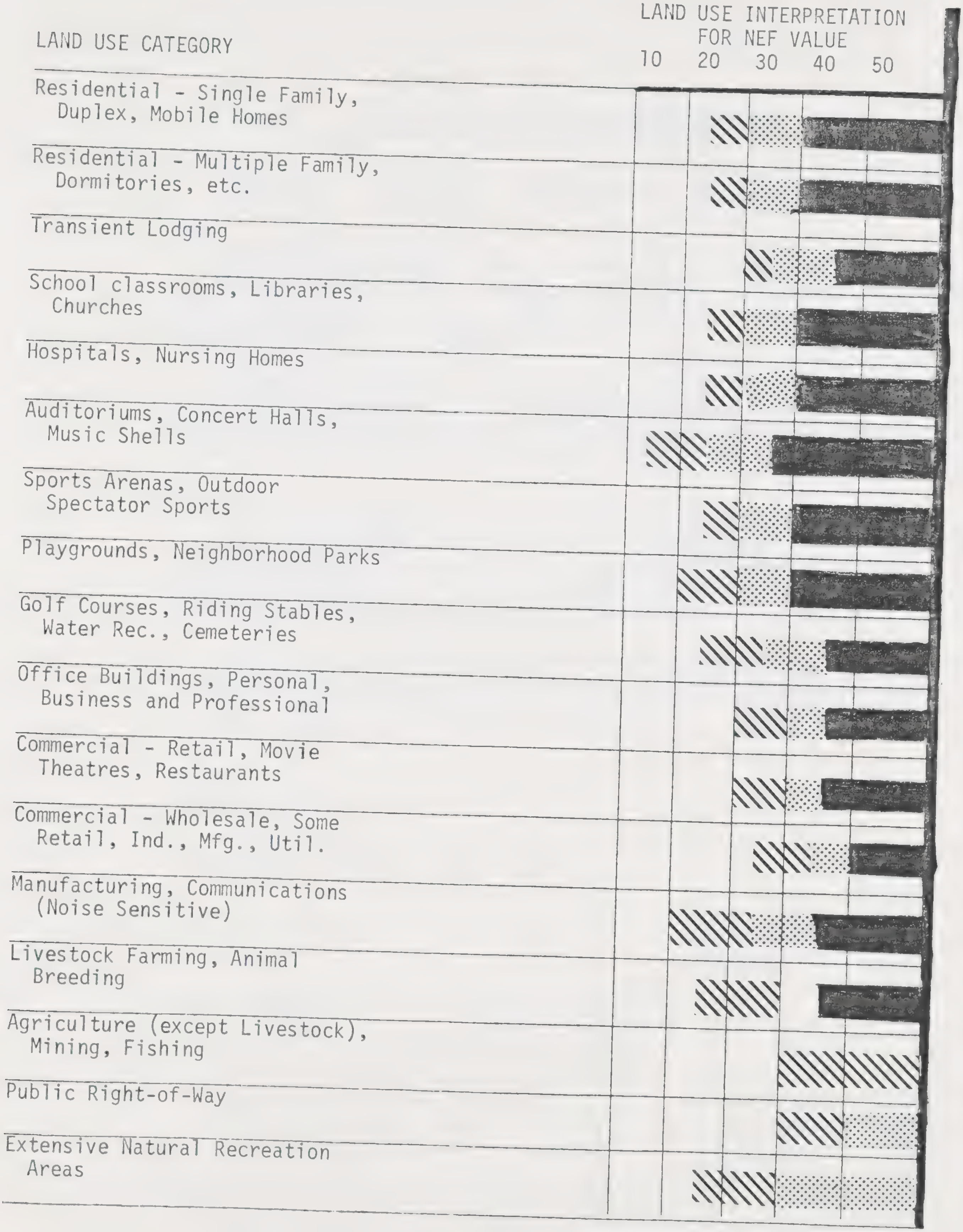
Design Noise Level (Vehicular traffic) and Land Use Relationships

Land Use Category	Design Noise Level - L_{10}	Description of Land Use Category
A	60 dBA (Exterior)	Tracts of lands in which serenity and quiet are of extraordinary significance and serve an important public need, and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose. Such areas could include amphitheaters, particular parks or portions of parks, or open spaces which are dedicated or recognized by appropriate local officials for activities requiring special qualities of serenity and quiet.
B	70 dBA (Exterior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, picnic areas, recreation areas, playgrounds, active sports areas, and parks.
C	75 dBA (Exterior)	Developed lands, properties or activities not included in categories A and B above.
D	--	[Undeveloped lands]
E	55 dBA (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals and auditoriums.

(Source: U. S. Department of Transportation, Federal Highway Administration, Transmittal 90-2, Feb. 8, 1973: Federal Noise Standards.)

Figure IV - 8

LAND USE COMPATIBILITY GUIDELINES FOR AIRCRAFT NOISE ENVIRONMENTS



HUD, Aircraft Noise Impact: Planning Guidelines for Local Agencies, p. 54)

Figure IV-9

(Notes for Figure IV-8)

Clearly Acceptable	Normally Acceptable	Normally Unacceptable	Clearly Unacceptable

<u>Clearly Acceptable</u>: The noise exposure is such that the activities associated with the land use may be carried out with essentially no interference from aircraft noise. (Residential areas: both indoor and outdoor noise environments are pleasant.)

<u>Normally Acceptable</u>: The noise exposure is great enough to be of some concern, but common building constructions will make the indoor environment acceptable, even for sleeping quarters. (Residential uses: the outdoor environment will be reasonably pleasant for recreation and play.)

<u>Normally Unacceptable</u>: The noise exposure is significantly more severe so that unusual and costly building constructions are necessary to ensure adequate performance of activities. (Residential areas: barriers must be erected between the site and prominent noise sources to make the outdoor environment tolerable.)

<u>Clearly Unacceptable</u>: The noise exposure at the site is so severe that construction costs to make the indoor environment acceptable for performance of activities would be prohibitive. (Residential areas: the outdoor environment would be intolerable for normal residential use.)

State Noise Standards

At the state level, the California Vehicle Code limits noise levels of vehicles to the following levels:

	Speed limit of 35 mph or less	Speed limit of more than 35 mph
(1) Any motor vehicle with a manufacturer's gross vehicle weight rating of 6,000 pounds or more and any combination of vehicles towed by such motor vehicle:		
(A) Before January 1, 1973	88 dB(A)	90 dB(A)
(B) On and after January 1, 1973 ...	86 dB(A)	90 dB(A)
(2) Any motorcycle other than a motor-driven cycle ...	82 dB(A)	86 dB(A)
(3) Any other motor vehicle and any combination of vehicles towed by such motor vehicle	76 dB(A)	82 dB(A)

Regulations also govern noise from airports and aircraft. Insulation standards in the Administrative Code regulate noise transmission in buildings.[52]

City of Merced Noise Standards

The City Code has three areas where noise is discussed: one is covered under Section 16.15, use of vehicle equipped with sound-amplifying devices; the second is covered under Section 5.25.2, public nuisance (animal noise); and the third, covered under Section 8.1, is included as a result of the adoption of the Uniform Building Code. Indirectly, noise levels are being regulated by land use planning as in industrial siting, and by circulation planning as in the establishment of truck routes. When enforced, these regulations and standards contribute to a quieter environment. The following section of goals and policies is intended to guide continued and expanded efforts to reduce noise and noise impacts in Merced.

NOISE ELEMENT GOALS AND POLICIES

GOALS

1. To improve environmental quality by reducing overall noise levels within the City of Merced.

2. To provide a comprehensive mechanism for dealing with noise in the City of Merced.

POLICIES

Reduction of Equipment Noise Levels

1. To limit operating hours for noisy equipment used in the City of Merced.

2. To review City functions (e.g., construction, refuse collection, street sweeping, tree trimming) to insure that noise generated by equipment has been reduced to the lowest practical level.

3. To include minimum noise level requirements in specifications for City equipment purchases and construction contracts.

Reduction of Surface Vehicle Noise

4. To support the state legislature in lowering the permissible noise levels of vehicles.

5. To synchronize traffic signalization where possible to minimize noise; to limit vehicular speed where high noise cannot be tolerated.

6. To review existing truck routes and suggest changes where necessary that will reduce noise impact on sensitive land uses; to divert through traffic from residential streets.

7. To require noise barriers between heavy circulation corridors and noise intolerant areas.

8. To measure noise levels on major streets and to utilize model generated noise contours for delineating possible problem areas; to require field measurements when new development may be impacted by high noise levels.

9. To study the possibility of moving rail traffic from more noise sensitive areas to railways in less sensitive areas.

Reduction of Aircraft Noise

10. To devote full attention to airport master planning with regard to the Merced Airport and to include the following means where possible:

    (a) Public acquisition of land,
    (b) Barriers for ground level operations, and
    (c) Market services to attract land uses that are more tolerant of noise.

11. To encourage airport management techniques that will keep noise conflict to a minimum, including changes in flight schedules, and where possible, changes in flight patterns and landing/take-off techniques.

12. To utilize model generated noise contours for delineating possible problem areas and to require field measurements when new development may be impacted by high noise levels.

<u>Reduction of Noise Levels at the Receiver Where Cost Prohibits Noise Reduction at the Source</u>

13. To provide information on insulation techniques that can be used in existing homes to lower sound transmission as well as reduce heating and cooling costs.

14. To encourage sound masking techniques in commercial and office buildings where noises are disruptive.

15. To provide quiet zones in existing and future recreational areas.

16. To revise the zoning and subdivision ordinances to include control mechanisms for noise sensitive areas and uses, e.g., residential development.

<u>Reduction of Overall Noise Levels in the City of Merced</u>

17. To adopt a Noise Ordinance for the City of Merced.

18. To set up an enforcement program including a liaison with the Merced County Health Department for assistance in on-site noise measurements and preparation of noise standards.

19. To initiate an educational program that includes public involvement and distribution of information on noise impact.

20. To review other elements of the General Plan to examine possible conflict between high noise levels and noise sensitive land uses.

SELECTED DESIGN TECHNIQUES

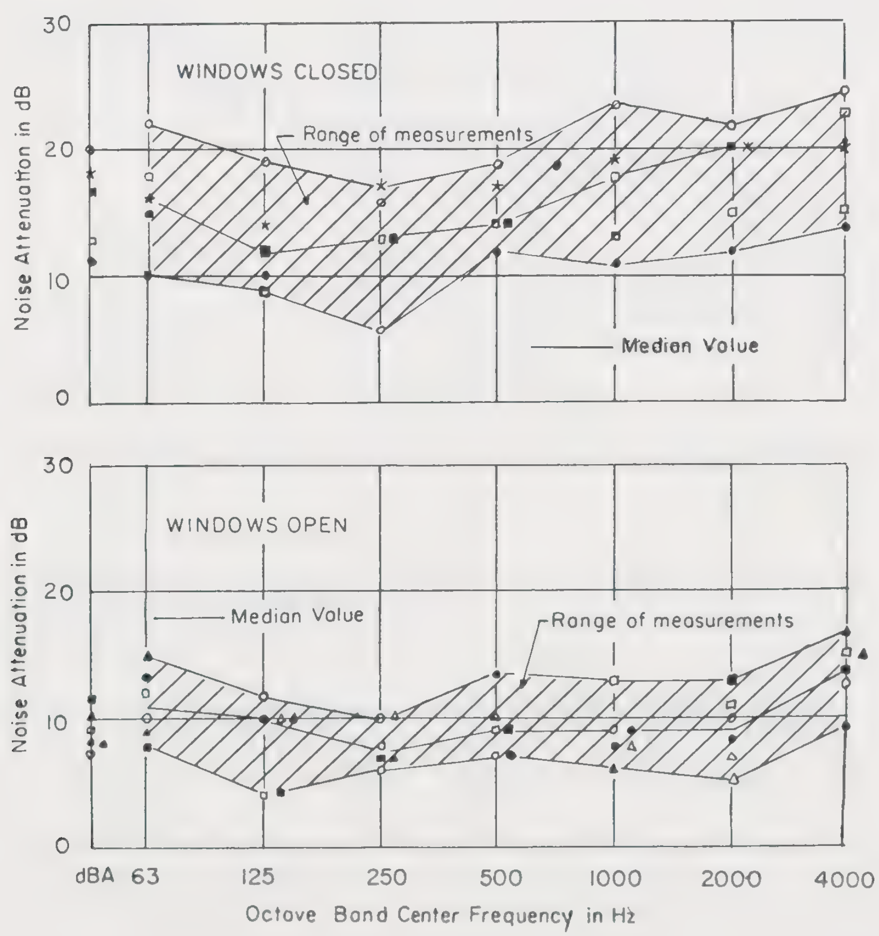
In some instances, noise cannot be decreased at the source and it is only possible to modify the environment about the receiver in order to lessen the impact. The following examples illustrate how this can be accomplished.

Design Techniques for Reducing Noise Transmission into Buildings

The easiest step to take to decrease the amount of noise transmitted into a building is to close the windows. The following figure shows the difference in noise attenuation in a building with windows open and with them closed.

Figure IV-10

Effect of Windows on Noise Attenuation



(Source: HUD, Aircraft Noise Impact: Planning Guidelines for Local Agencies, p. 217)

Actual design techniques are more difficult and costly to implement, especially on existing buildings. These techniques include: (1) elimination of openings with a closed circulation system; (2) placement of windows, doors and vents so that a direct line is avoided; (3) reduction of the amount of open area; (4) insulation of floors, roof, and walls; (5) double-paned windows; and (6) extension of the roof line.[53]

The following three stages can be implemented to increase noise attenuation. Estimated costs in 1969 dollars are included.

Stage 1 improvements: Cost: \$2.10/ft^2	Repair cracks and openings. Replace hollow core doors with well-fitted solid core doors with seals. Improve window seals for all windows except those on sheltered side of the building.
Stage 2 improvements: Cost: \$3.15/ft^2 without beamed ceiling; \$4.20/ft^2 with beamed ceiling.	Replace all exterior doors with acoustical doors and seals. Double glaze windows on all but sheltered side. Install fireplace dampers. Install modified vent ducts with a bend and acoustic lining. Provide external auxiliary roof section for rooms with beamed ceilings.
Stage 3 improvements: Cost: \$8.15/ft^2 without beamed ceiling.	Include sound traps inside foundation vents. Fiberglass batts between floor joints. Chemical foam insulation between ceiling joints. Double ceiling of fiberglass batts and wood fiber sound deadening board.

(Source: HUD, Aircraft Noise Impact: Planning Guidelines for Local Agencies, p. 224-5)

Design Techniques for Reducing Impact of Transportation Noise

Several design techniques have been used to reduce the impact of transportation noise on surrounding land uses. Where there is plenty of space, a solid, wooded strip of 100 feet in width will provide a decrease of 5 dB(A).[54] A grade separation will also cause less noise to reach buildings bordering traffic arteries, but can increase the noise impact on more distant areas as a result of the increased acceleration.

The road surface can affect noise levels, especially with respect to truck traffic. A very rough road can increase noise levels by 5 dB(A) and a very smooth road, which would probably be too slippery when wet, can decrease noise levels by up to 5 dB(A).[55]

The most widely used noise attenuating technique is the barrier. To be effective, a barrier must block the line of sight between the source (normally measured at 8 feet above the roadway) and the receiver. For this reason, barriers provide little or no attenuation for second stories of buildings. Barriers should also be continuous since openings have a negative effect on the ability to attenuate noise.[56]

Barriers can be made of different materials although the rule of thumb requirement is that the mass weight should be no less than 2 lbs/ft^2 and no more than 4 lb/ft^2.[57] If earth is available, the earth berm can be the most effective barrier, visually and functionally. To obtain a 5 dB(A) reduction in noise, the barrier must have a transmission loss of 15, that is, there must be a 10 dB(A) difference between the desired amount of reduction and the transmission loss of the material of the barrier.[58] The following chart lists materials and their respective transmission loss rates:

Material	Transmission Loss (dB(A)*
Timber, Fir (1 inch thick, 3.3 lb/ft^2)	21
Timber, Fir (2 inch thick, 6.7 lb/ft^2)	24
Plywood (1 inch thick, 3.3 lb/ft^2)	23
Cinder Block Hollow Core (6 inch thick, 25 lb/ft^2)	28
Concrete Block Hollow Core (4 inch thick, 23.3 lb/ft^2)	30
Concrete Block Hollow Core (6 inch thick, 35 lb/ft^2)	36
Brick (4 inch thick, 50 lb/ft^2)	33
Concrete, Dense (4 inch thick, 50 lb/ft^2)	35
Glass (1/8 inch thick, 1.6 lb/ft^2)	22
Steel, Flat or Corrugated (18 gage, 0.0375 inch thick, 2.0 lb/ft^2)	25

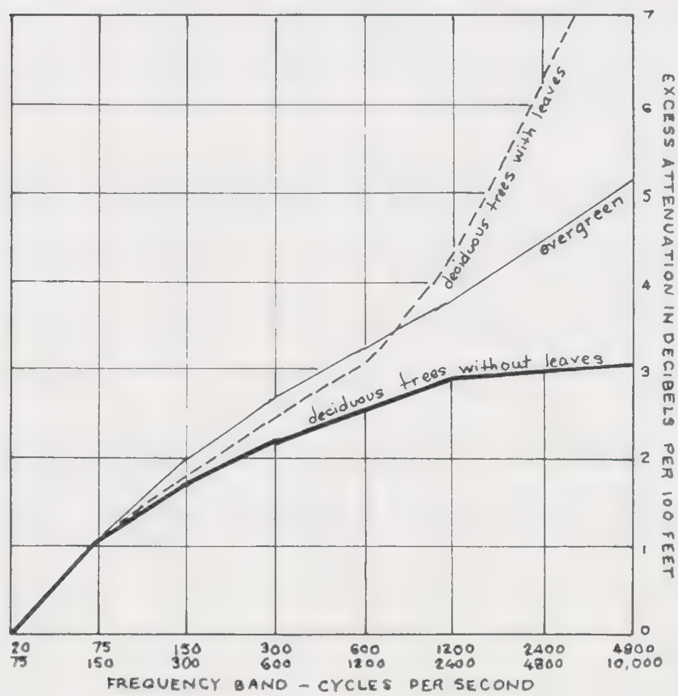
*A-weighted transmission loss based on generalized truck spectrum at 50 feet for all speeds.

(Source: U. S. Department of Transportation, Fundamentals and Abatement of Highway Traffic Noise, Vol. 2, p. I-10)

Vegetation can also be used as a barrier to provide noise attenuation. "Plants, while not absolutely effective in the screening of all sounds, do seem to screen out sound levels sensitive to human ears. . . . by modifying climatic conditions, and by absorption, deflection, refraction, and reflection of noise."[59] The following chart illustrates the excess attenuation (above and beyond the attenuation from distance alone) provided by plants:

Figure IV-11

Excess Attenuation in Octave Band for Sound Propagation in Tree Areas in dB per 100 ft.

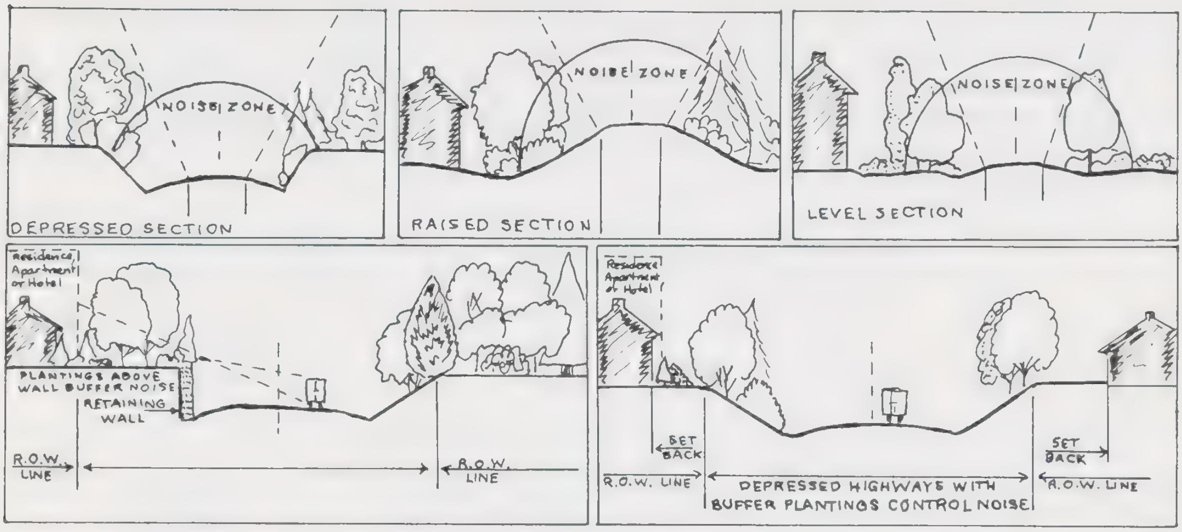


(Source: Robinette, Plants/People/and Environmental Quality, p. 43.)

Findings differ on how much vegetation is necessary to provide adequate attenuation. Some sources suggest that 100 feet of solid trees would lower noise levels by 5 dB(A).[60] One source states that a 25 to 35 foot plant screen would be effective for highway noise, provided that the plant-

ing consisted of both trees and shrubs, preferably evergreen.[61] Figure IV-12 illustrates how trees and shrubs would affect the spread of noise.

Figure IV-12



(Source: Robinette, Plants/People/and Environmental Quality, p. 47)

Still another source states: "Distances of 75 feet or more should be available for planting between the noise sources and the area to be protected. Dense barriers formed by planting several rows of trees closely together are most effective. Noise screens should be placed as close as possible to the noise sources, consistent with safety."[62]

Footnotes

1. California Government Code, Section 65302.
2. U.S. Department of Transportation, Federal Highway Administration, National Highway Institute, Fundamentals and Abatement of Highway Traffic Noise (Prepared by Bolt, Beranek and Newman, Inc.), June, 1973, p. 1-19.
3. William S. Gatley and Edwin E. Frye, "Regulation of Noise in Urban Areas," Environmental Protection Agency, Office of Noise Abatement and Control. August, 1971, p. II-1.
4. Randall L. Hurlburt, "Community Noise Control: Training Guide and Enforcement Manual" (Appendix 7 of "Noise Control, Legislation, and Enforcement"), City of Inglewood, California, September, 1971, p. 2.
5. Gatley, "Regulation of Noise in Urban Areas," p. III-3.
6. Envicom Corporation, "Noise in the Fresno County Region," Council of Fresno County Governments, 1975, p. 14.
7. Ibid., p. 14.
8. U.S.D.O.T., Fundamentals and Abatement of Highway Traffic Noise, p. 2-1.
9. Envicom Corporation, "Noise in the Fresno County Region," p. 17.
10. U.S. Department of Housing and Urban Development, Aircraft Noise Impact: Planning Guidelines for Local Agencies, November, 1972, p. 20.
11. U.S.D.O.T., Fundamentals and Abatement of Highway Traffic Noise, p. 1-1.
12. Envicom Corporation, "Noise in the Fresno County Region," p. B-7.
13. Hurlburt, "Community Noise Control: Training Guide and Enforcement Manual," p. 3.
14. U.S.D.O.T., Fundamentals and Abatement of Highway Traffic Noise, p. 1-7.
15. Ibid., p. 1-13.
16. Ibid., p. 1-8.
17. Ibid., p. 1-11.
18. U.S.H.U.D., Aircraft Noise Impact, p. 36.
19. U.S. Environmental Protection Agency, Effects of Noise on People, (Prepared by Central Institute for the Deaf), December 31, 1971, p. 123.
20. Ibid., p. 39.
21. Ibid., p. 39.
22. Ibid., p. 40.
23. Ibid., p. 73.
24. Ibid., p. 74.
25. Ibid., p. 76.
26. U.S. Environmental Protection Agency, Social Impacts of Noise, December 31, 1971, p. 22.
27. U.S.E.P.A., Effects of Noise on People, p. 76.
28. Ibid., p. 78.
29. Ibid., p. 129.
30. Ibid., p. 131.
31. Ibid., p. 131.
32. Ibid., pp. 51-52.
33. Ibid., p. 55.
34. Ibid., p. 56.
35. Ibid., pp. 54-55.
36. Ibid., p. 55.

37. U.S. Environmental Protection Agency, Economic Impact of Noise, (Prepared by National Bureau of Standards), December 31, 1971, p. 23.
38. Ibid., p. 23.
39. Ibid., p. 53.
40. Ibid., p. 57.
41. Ibid., p. 58.
42. U.S. Environmental Protection Agency, Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances, (Prepared by Bolt, Beranek and Newman, Inc.), December 31, 1971, p. 27.
43. Correspondence from Ray Carroll, Chief, Environmental Branch, CALTRANS, State of California, Department of Transportation, dated April 18, 1975.
44. Ibid.
45. Telephone call, Robert Horn, Environmental Branch (see above), July 3, 1975.
46. U.S.D.O.T., Fundamentals and Abatement of Highway Traffic Noise, p. 2-1.
47. Telephone call, Southern Pacific Railroad, Merced, May, 1975, and correspondence, G. E. Becker, Superintendent, Atchison, Topeka & Santa Fe Railway, dated May 13, 1975.
48. Wyle Laboratories, "Assessment of Noise Environments Around Railroad Operations," July, 1973, pp. 3-24 to 3-36.
49. U.S.H.U.D., Aircraft Noise Impact, pp. 191-209
50. Castle Air Force Base, "Air Installation Compatible Use Zone (AICUZ) Castle Air Force Base, California," September, 1974.
51. Joseph Less, "The Aircraft Noise Problem: Federal Power but Local Liability," from The Urban Lawyer, American Bar Association, Vol. 3, No. 2, pp. 199-200.
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53. U.S.H.U.D., Aircraft Noise Impact, pp. 224-225.
54. U.S.D.O.T., Fundamentals and Abatement of Highway Traffic Noise, p. 1-13.
55. Ibid., p. 2-3.
56. U.S. Department of Transportation, Fundamentals and Abatement of Highway Traffic Noise: Vol. 2: Noise Barrier Design and Example Abatement Measures, April, 1974, p. I-16.
57. Ibid., p. I-9.
58. Ibid., p. I-13.
59. Gary O. Robinette, Plants/People/and Environmental Quality, U.S. Department of Interior, 1972, p. 41.
60. Ibid., p. 43, citing Bolt, Beranek and Newman, Inc.
61. Ibid., p. 44, citing Traffic Quarterly (Bruce Sexton).
62. Ibid., p. 44, citing David Cook and David Van Haverbeke.

APPENDIX IV-A

METHODOLOGY AND COMPUTATIONS

Noise Contours for Highways and Freeways

Noise contours down to 60 dB(A) for highways and freeways in the City of Merced were developed by CALTRANS, District 10 office, using the National Cooperative Highway Research Program Report #117 traffic noise model. No actual measurements were taken and, therefore, no consideration was given to intervening structures which can affect noise level. "As a rule of thumb, one can assume that 5 dB(A) reduction is provided by one row of houses and a maximum of 10 dB(A) reduction for two or more rows of houses. These values assume rather dense packing of the houses." (Letter dated April 18, 1975, from Ray Carroll, Chief, Environmental Branch

Using a formula provided by Bolt, Beranek, and Newman, Inc., noise contours down to 45 dB(A) were developed to determine noise levels near hospitals, schools and parks.

For surface traffic, the L_{10} contours were computed also using the NCHRP #117 method. Included in the calculations were the peak hour traffic count, average speed of traffic, percentage of trucks, and number of lanes. In some cases, the resultant figures were too low (below 45 dB(A) at 50 feet) and contours were not drawn.

Where the daily traffic count was less than 10,000 vehicles, an additional computation suggested by the Federal Highway Administration ("Highway Noise Prediction Techniques," June 9, 1975) was used to provide more accuracy in dealing with such low volume counts.

L_{10} CONTOUR DISTANCE TO CENTER OF NEAR LAND (WHERE DISTANCE IS GREATER THAN 40')

Route: Highway 99

Segment:		dB(A): 85	80	75	70	65	60	55	50	45
Madera-Merced Co. line to Childs Avenue	1973		55'	107'	196'	355'	653'			
	1995	47'	85'	152'	277'	514'	974'			
Childs Avenue to Jct. Rte. 140 E.	1973		54'	106'	196'	355'	651'			
	1995	46'	85'	152'	275'	507'	956'			
Jct. Rte. 140 E. to N. Jct. Rte. 59 & 140	1973		56'	110'	204'	373'	691'	1380'	2400'	3590'
	1995	48'	88'	158'	288'	535'	1019'	1880'	2960'	4270'
N. Jct. Rte. 59 & 140 to W. Merced Overhead	1973		53'	104'	196'	356'	657'			
	1995	44'	83'	149'	271'	502'	949'			
W. Merced Overhead to Buhach Road	1973		62'	119'	216'	397'	741'			
	1995	55'	96'	174'	319'	596'	1154'			

Route: Highway 140

Segment:		dB(A): 85	80	75	70	65	60	55	50	45
Applegate Rd. to Franklin Rd.	1973				50'	87'	151'			
	1995				62'	111'	201'			
Franklin Rd. to N. Jct. Rte. 99.	1973				53'	92'	163'			
	1995				58'	108'	206'			
S. Jct. Rte. 99 to Santa Fe Dr.	1973				63'	129'	250'	538'	1140'	2090'
	1995			48'	100'	193'	338'	731'	1470'	2500'
Santa Fe. Dr. to Arboleda Dr.	1973				71'	132'	252'			
	1995				81'	161'	299'			

Route: Highway 59

Segment:		dB(A): 85	80	75	70	65	60	55	50	45
McNamara Rd. to Childs Avenue	1973				63'	116'	216'			
	1995			48'	94'	179'	330'			
Childs Ave. to S. Jct. Rte. 99	1973				84'	165'	291'	629'	1290'	2290'
	1995		41'	82'	147'	252'	430'	922'	1770'	2840'

L_{10} CONTOURS (Cont'd)

Segment:		dB(A): 85	80	75	70	65	60	55	50	45
N. Jct. Rte. 99 to	1973			48'	99'	188'	323'			
S. Jct. 16th St.	1995		48'	92'	160'	276'	478'			
S. Jct. 16th St.	1973				60'	115'	219'			
to N. Jct. 16th St.	1995			61'	119'	216'	364'			
N. Jct. 16th St.	1973				64'	116'	212'			
to Santa Fe Dr.	1995				74'	142'	265'			
Santa Fe. Dr. to	1973					75'	132'			
Oakdale Rd.	1995				57'	100'	184'			

Note: One segment of Highway 59 has been erroneously shown as following 16th Street through Merced. It actually follows the same route as Highway 99 from "J" Street to "V" Street to 16th Street. Because the contours were derived from actual traffic counts, there would be no difference on Highway 99. Also, the slight difference in traffic amount between "J" Street and "V" Street would justify using the same contours for both streets.[45] Corrections have been included on the preceding map and the noise contours for 16th Street have been retained.

Route: "G" Street

Segment:		85	80	75	70	65	60	55	50	45
Olive Avenue intersection	1971			55'	100'	200'	360'	700'	1300'	2600'
Alexander Ave. intersection.	1971			80'	170'	400'	850'	1800'	3500'	--
North Bear Creek Dr. intersection	1975		60'	130'	280'	600'	1500'	3000'	6000'	--
Santa Fe Rail tracks intersection	1975		75'	160'	290'	600'	1300'	2400'	4500'	--

L_{10} CONTOURS (Cont'd)

Route: "G" Street

Segment:		dB(A): 85	80	75	70	65	60	55	50	45
18th Street intersection	1975					75'	140'	220'	390'	690'

Route: Olive Avenue

Segment:		dB(A): 85	80	75	70	65	60	55	50	45
Hwy. 59 to "R" St.	1974				50'	100'	200'	400'	750'	1500'
"R" St. to "M" St.	1974					80'	200'	400'	1000'	2500'
"M" St. to "G" St.	1974					80'	170'	325'	650'	1300'

Noise Contours for Railways

The following steps were taken to determine the Day-Night Noise Level for railroad operations in the City of Merced:

(1) Determine duration of train pass-by in seconds (t).
$t = 0.68 \times \frac{\text{Length (feet)}}{\text{Velocity (mph)}}$, seconds

(2) Determine C2 duration term
$C2 = 10 \log_{10} t$

(3) Determine C1, typical A-weighted sound pressure level of freight cars at 100 feet. (Chart 3.4-2: All charts can be found in "Assessment of Noise Environments Around Railroad Operations," Wyle Laboratories, July, 1973.)

(4) Determine distance attenuation factor, $\propto$, for car-generated noise. (Chart 3.4-4.)

(5) Determine C3, car noise adjustment factor. Presence of grade crossing: C3 = 8.

(6) Calculate SENEL of cars alone at distances specified.
$SENEL_{car} = C1 + C2 + C3 - \propto$.

(7) Determine C4, locomotive SENEL contribution at 100 foot reference distance from track. (Chart 3.4-6.)

(8) Determine distance attenuation factor $\propto$ for engine-generated noise levels. (Chart 3.4-4.)

(9) Calculate SENEL of locomotives alone at distances specified.
$SENEL_{engine} = C4 - \propto$.

(10) Determine total SENEL of train by logarithmic summation of engine and car contributions. $SENEL_{train}$ = larger of $SENEL_{car}$ and $SENEL_{engine}$ plus increment determined by difference of these two values. (Chart 3.4-1.)

(11) Resolution of traffic mix for each train category type into equivalent number of daily operations. $N = N_{day} + 10N_{night}$.

(12) Determine L_{dn} contribution for N for each distance. (Chart 3.4-9.)

The following values were used to determine L_{dn} for the two railways:

Southern Pacific: 15 trains = N_{day}; 12 trains = N_{night}; Average length of train = 6500 feet; Velocity (V) = 45 mph; L_{dn} values calculated for distances of 200, 400, and 800 from the center of the track.

Santa Fe: 9 trains = N_{day}; 7 trains = N_{night} (passenger trains having only 4 cars were not included; charts did not have that degree of accuracy); Average length = 5610 feet; Velocity (V) = 30 mph; L_{dn} values calculated for distances of 200, 400, and 800 from the center of the track.

Noise Contours for Aircraft from Merced Municipal Airport

Noise contours from Castle Air Force Base have been developed by Castle Air Force Base and the calculations are not included here. Noise contours for the Municipal Airport were calculated using the formula provided by HUD in Aircraft Noise Impact:

$$NEF = EPNL + 10 \log \left(\frac{N(day)}{K(day)} + \frac{N(night)}{K(night)} \right) - C$$

where

NEF = Noise Exposure Forecast value produced by the aircraft class along the particular flight path segment.

EPNL = Effective perceived noise level produced at the given point by the aircraft class flying along the given flight path segment. (Found in Aircraft Noise Impact.)

K = Constant normalizing the adjustment in NEF values due to volume of operations. Different values of K are used for daytime and nighttime movements. K(day) = 0; K(night) = 1.2.

C = Arbitrary normalization constant, chosen to make NEF values distinct from other noise descriptors. C = 75.

The total NEF at the given ground position may be determined by summation of all the individual NEF values on an "energy" basis:

$NEF = 10 \log \sum \text{antilog} \frac{NEF}{10}$, summing for all the flight paths and aircraft classes affecting the location. These values are plotted on a map about the airport run-way(s) to get NEF contours.

The following figures were used to determine NEF for the Municipal Airport (provided by Kenneth Coe, Merced Municipal Airport Flight Line):

Aircraft type	Number of day operations	Number of night operations
Business Jet	1	0
737	2	0
2-engine prop	4	0
1-engine	31	4

(Note: No EPNL contours were available for a 1-engine prop, so the the contours for the small 2-engine were used.)

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